Acute apical endodontic abscesses: the role of bacteria, geography, and synergy

In conditions of health, the root canal of the tooth is essentially sterile and devoid of the hundreds of microbial species that colonize the oral cavity. When oral bacteria are permitted to access the pulp – whether through trauma, caries, or iatrogenic introduction – endodontic disease often occurs, aggravated by the influx of inflammatory cells and leading to pulpitis and periapical periodontitis. In response to pulpal infection, the immune system often initiates the formation of an acute apical abscess, characterized clinically by pain, sensitivity of the tooth to pressure, and swelling of the surrounding tissues. This acute inflammatory response leads to bone resorption surrounding the apex of the tooth and may also spread to the surrounding tissues resulting in cellulitis.

The primary objective of our recent study was to identify the oral microbiota in patients (N=18) exhibiting acute apical abscesses from the Portland, Oregon geographic region. The study hypothesis was that abscesses in this geographic region may contain significant microorganisms not identified in other regions. The classification of bacterial species in acute apical abscesses has allowed us to designate new candidate microorganisms and synergistic relationships that may contribute to the progression of endodontic disease.

We examined acute apical abscesses for the presence of 280 different oral bacteria. The five most prevalent taxa were *Fusobacterium nucleatum, Parvimonas micra, Megasphaera* species clone CS025*, Prevotella multisaccharivorax*, and *Atopobium rimae*. The five taxa with the highest abundance were *F. nucleatum*, *P. micra*, Streptococcus Cluster III, *Solobacterium moorei*, and *Streptococcus constellatus*. The number of bacterial species isolated from individual abscess specimens ranged from 2 to 30 (mean=15.9; median=17).

Using a pioneer study by Siqueira and Rôcas in Rio de Janeiro, Brazil as a means of comparison, we have identified significant geographic variations in the bacterial composition of acute apical abscesses. The studies in Portland, Oregon and Rio de Janeiro, Brazil were consistent in identifying *F. nucleatum, P. micra,* and *Porphyromonas endodontalis* as highly prevalent microorganisms in endodontic abscesses. However, the abscess specimens in Rio de Janeiro were found to have a high prevalence of *Treponema denticola* and *Tannerella forsythia*, which were absent or minimally present in the Portland, Oregon study group. These findings support the notion that geographic location may play a pivotal role in governing the bacterial composition of acute apical abscesses.

F. nucleatum has been shown to enhance the adhesion and invasion of other oral microorganisms. In addition, coinfection of *F. nucleatum* with other microorganisms may inhibit the immune response and lead to bacterial proliferation. Accordingly, we have identified key bacterial associations between *F. nucleatum* and several other species, including *Mycoplasma salivarium*,

Porphyromonas gingivalis, and *Megasphaera* species clone. The role of *F. nucleatum* in synergistically enhancing the virulence of other species and inhibiting the host immune response is likely an essential determinant of endodontic and periodontal disease.

We have also identified a bacterium, *Streptococcus cristatus*, which has not been recognized in previous studies of endodontic disease. *S. cristatus* has been shown to have an inhibitory effect on the immune system by the attenuation of interleukin-8 in the inflammatory pathway. It also inhibits the adhesion and colonization of *P. gingivalis* by inhibiting the expression of the fimbrillin (FimA) gene. *S. cristatus* thus appears to attenuate the pathogenicity of *P. gingivalis* and contributes to decreased inflammation and decreased alveolar bone loss in periodontal disease.

The Portland, Oregon study supports the findings of previous studies and has further identified strong bacterial associations that underscore the importance of geographic variation and synergistic bacterial relationships in the etiology of endodontic disease. Furthermore, the novel identification of *S. cristatus* in endodontic abscesses may further shed light on the dynamic processes contributing to endodontic disease.

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